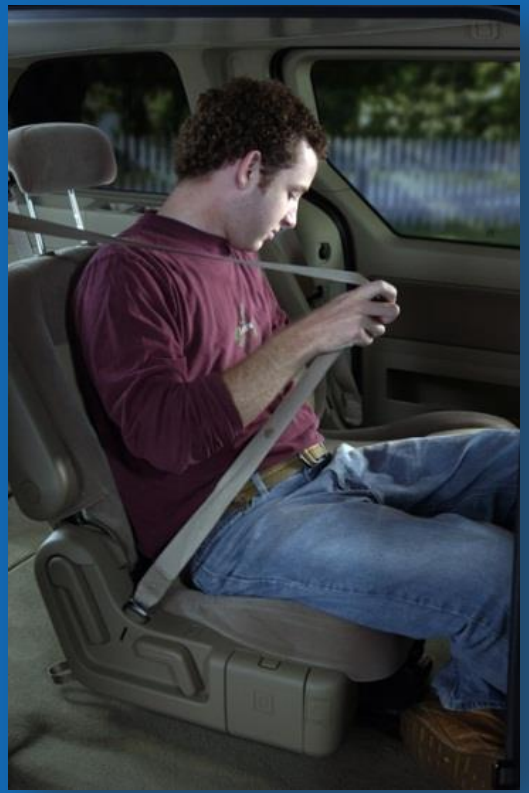
NHTSA's Research on Seatbelt Interlock and Alcohol Detection Technologies

February 1, 2018

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Background



NHTSA

Background

- In 2016, unrestrained passenger vehicle occupant fatalities increased by 4.6 percent, from 9,968 to 10,428 (+460).
- Among passenger vehicle occupants killed in 2016, almost half (48%) were unrestrained
- Seat belt use in 2017 dropped to 89.7 percent, down from 90.1 percent in 2016
- MAP-21 modified US Code to permit seat belt interlocks as a compliance option

Seat Belt Assurance Systems: Research Objectives and Approach

- Objective: Collect and interpret data related to seatbelt assurance systems:
  - System effectiveness
  - User acceptance
  - Unintended consequences

- Approach
  - Field operational test
    - Part-time seat belt users
    - Collection of objective driving data through naturalistic driving data
    - Collection of subjective data through a survey questionnaire

Experimental Design

- Mixed Design
  - Two seat belt assurance systems
    - Vehicles with transmission interlock (General Motors)
    - Vehicles with speed limiter (BMW)
  - 48 subjects
    - System condition (one week of baseline, two weeks of treatment)
    - Belt user group (Frequent seat belt users, Infrequent seat belt users)
    - Gender (Male, Female)
    - Age (Younger, Middle-aged)

Week	BMW System (A)	GM System (B)
1	Baseline_SystemA	Baseline_SystemB
2	SystemA	SystemB
3	SystemA	SystemB
# of participants	n=24	n=24

Test Vehicles with Speed Limiter Assurance (BMW)

- 2014 BMW X5
- Prevent vehicle with unbelted driver/passenger from driving faster than 15 mph;
- The system will issue continuous aggressive seatbelt reminder, acoustic and optical warning in central display;
- When the assurance system is activated and drivers remain unbelted, speed will be reduced automatically to 15 mph at a certain deceleration level after a certain period of warning time;
- Both visual and auditory signals will be issued to drivers by the seatbelt assurance system.

NHTSA

Test Vehicles with Transmission Assurance (General Motors)

- 2014 Chevrolet Cruze
- Prevent drivers from shifting into gear if driver/front passenger is unbelted;
- Sensors used for driver side are buckle, brake, and transmission status. Sensors used for passenger side include buckle and seat occupant;
- The basic or enhanced seat belt reminder in these vehicles (baseline condition for this vehicle) have both visual and audio warnings;
- Both visual and auditory signals will be issued to drivers by the seatbelt assurance system.

Vehicle Instrumentation

- Each vehicle was equipped with an UMTRI data acquisition system (DAS):
  - Embedded microcontroller board for recording objective data
  - Video module for recording the forward scene
  - Video module for recording the vehicle cabin (with audio)
  - Infrared cabin illumination
  - GPS receiver
  - CAN bus interface
  - Custom power/interface/controller board





Recruitment and Eligibility

- Recruitment
  - Posted flyers (e.g., local community colleges, bars)
  - Ads online (e.g., UM's clinical research study site)
  - Subject pool from previous UMTRI field studies
  - Initial screening over the phone

- Eligibility criteria
  - Valid Michigan driver's license
  - Self-report being part-time or non-seatbelt user
  - Driven for at least 2 years and currently driving at least 5 days per week
  - Check their first week of driving data to validate if they are qualified for continuing with the treatment week

Results: Data Collection

- Data collection
  - Screened 2,900 drivers
  - 84 drivers enrolled and 48 qualified drivers completed three-weeks of participation
    - Ages between 19 and 60 years old with a mean age of 33 years old
    - 27 drivers from the speed limiter group (12 males, 15 females)
    - 21 drivers from the transmission interlock group (10 males, 11 females)

Results: Data Reduction

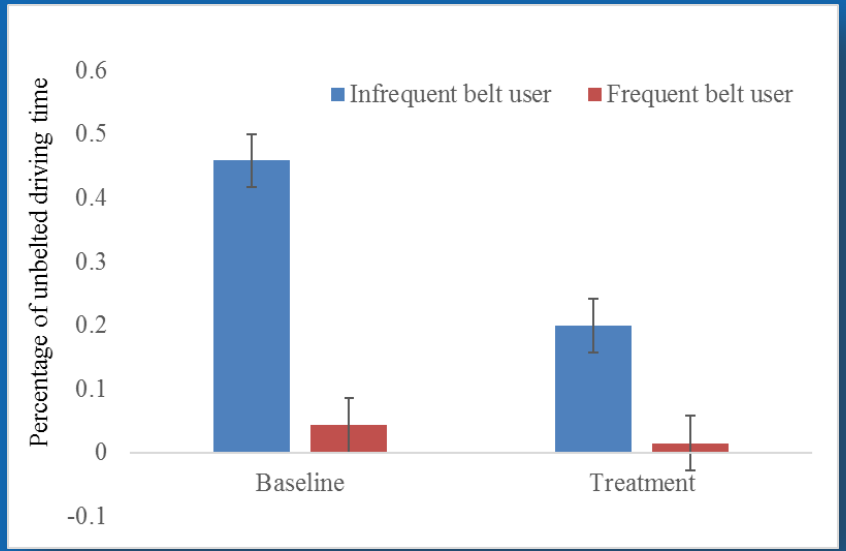
- A total of 6,254 valid trips were identified, representing 1,785.6 hours
- 48 drivers were divided into two groups with half of the participants classified as “Frequent Seat Belt Users” while the other half classified as “Infrequent Seat Belt Users” (though all were part-time users)

SBAS	Treatment	Belt-user group	# of valid trips	Driving hours	# of participants
Speed Limiter System	Baseline	Frequent-belt user	757	234.82	15 (6 male, 9 female)
Speed Limiter System	Baseline	Infrequent-belt user	554	178.00	12 (6 male, 6 female)
Speed Limiter System	Treatment	Frequent-belt user	1323	382.85	
Speed Limiter System	Treatment	Infrequent-belt user	858	283.83	
Transmission Interlock System	Baseline	Frequent-belt user	497	124.71	9 (5 male, 4 female)
Transmission Interlock System	Baseline	Infrequent-belt user	573	159.05	12 (5 male, 7 female)
Transmission Interlock System	Treatment	Frequent-belt user	676	136.36	
Transmission Interlock System	Treatment	Infrequent-belt user	1015	285.98	

Results: Percentage of unbelted moving time

$$\%\ of\ unbelted\ motion\ time\ = \frac{Total\ unbelted\ time\ when\ the\ car\ was\ in\ motion}{Total\ time\ when\ the\ car\ was\ in\ motion}$$

- Significant interaction effect between treatment and belt-user group F(1,44)=19.9, p<0.01)
- Significant treatment period effect (F(1,44)=30.94, p<0.01).
  - 24.1 percent during baseline
  - 10.7 percent during treatment
- No main effect of SBAS type was observed (p>0.05).
  - 16.5 percent for speed limiter group
  - 19.4 percent for transmission interlock group`

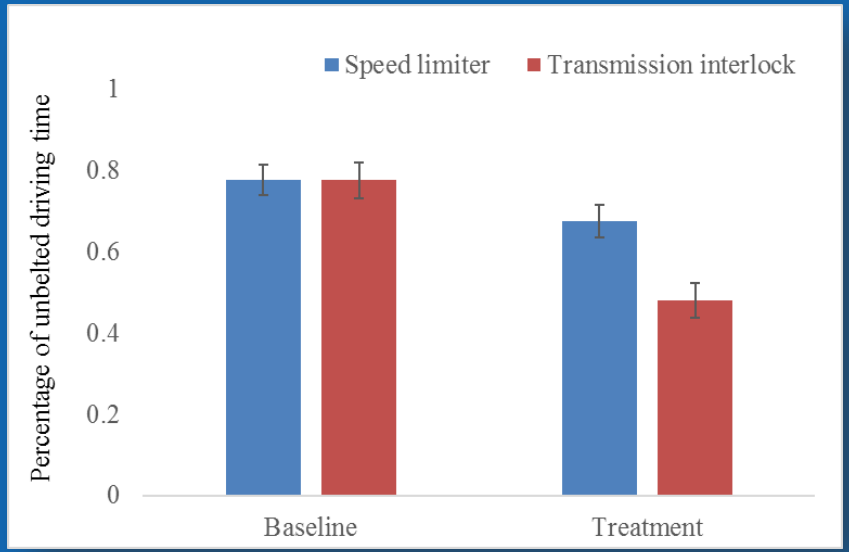


NHTSA

Results: Percentage of unbelted trips

$$\%\ of\ unbelted\ trip\ with\ motion\ = \frac{Total\ number\ of\ trips\ with\ unbelted\ behavior\ when\ the\ car\ in\ motion}{Total\ number\ of\ trips\ with\ motion}$$

- Significant interaction effect between treatment and SBAS type ($F(1,44) = 7.1$, $p<0.05$)
- Significant treatment period effect ($F(1,54)=25.2$, $p<0.05$)
  - 77.6 percent during baseline
  - 57.8 percent during treatment
- Significant SBAS ($F(1,41)=4.8$, $p<0.05$)
  - 72.6 percent for speed limiter group
  - 77.1 percent for transmission interlock group
- Significant belt-user group ($F(1,41)=18.2$, $p<0.05$)
  - 77.1 percent for infrequent belt users
  - 58.4 percent for Frequent belt users



NHTSA

Results: System Cheating Strategy

- Two main defeating methods were observed:
  - Buckling the belt before entering the vehicle and then sitting on it;
  - Waiting out the transmission interlock timer
- Three drivers tricked the SBRS during baseline period driving
- Eight drivers tricked the SBAS by not using the seat belts appropriately:
  - Five were from the transmission interlock system group
  - Three were from the speed limiter group
  - All infrequent-belt users
- Drivers from the transmission interlock group are about 2.5 times more likely to cheat than the drivers from the speed limiter group
- Drivers were 3 times more likely to cheat during treatment condition than during baseline condition

NHTSA

Conclusions and Discussions

- Significant system effects observed for both SBAS with an average of 14.4% increase in seat belt use while the vehicle was moving, or about 19.8% increase of belted trips from baseline to treatment condition
- This effectiveness was more pronounced for infrequent belt users than for frequent belt users
- Comparative differences between the two SBAS systems were observed with different measures:
  - The decrease in the percentage of unbelted trips (between treatment and baseline driving) for the speed limiter group was much less than for the transmission interlock group
  - Similar reductions in the percentage of unbelted driving time were observed for both SBAS groups

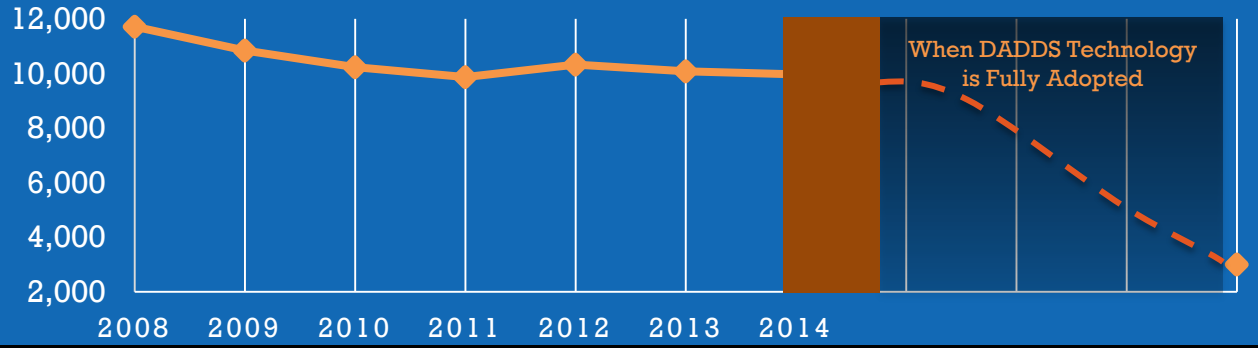
Conclusions and Discussions

- Two main system-defeating or “cheating” strategies were observed, pre-buckling then sitting on the seat belt and waiting out the transmission interlock timer
- All eight drivers who showed any SBAS cheating behavior were infrequent belt users
- Drivers from the transmission interlock group tended to be more likely to “cheat” the SBAS than drivers from the speed limiter group
- The SBAS may induce more cheating behavior
- Generally high levels of user-acceptance were observed
- Countermeasures for system defeating behavior are not available in either vehicle platform

Drunk Driving: The Problem and Opportunity

- Drunk driving remains a deadly problem
- Costs approximately 10,000 lives and $194 billion each year in the U.S.
- If driver BACs can be limited to less than 0.08 — the legal limit in all 50 states — approximately 7,000 lives could be saved annually

U.S. DRUNK DRIVING DEATHS



Source: NHTSA / Department of Transportation

NHTSA

The DADSS Solution

- The first-of-its kind technology will detect when a driver is intoxicated with a BAC at or above 0.08 and prevent the car from moving
- Made available as a safety option in new vehicles, much like automatic braking, lane departure warning and other advanced driver assist vehicle technologies
- Fast, accurate, reliable and affordable technology that will not affect normal driving behavior
- Two options are being explored for vehicle integration

dadss
Driver Alcohol Detection System for Safety

Phased Approach and Partnership

- Proof-of-principle prototype development
- Subsystem development and integration into research vehicle
- Further refinement of technology and test instruments, basic and applied research to understand human interaction with sensors, and Field Operational Tests

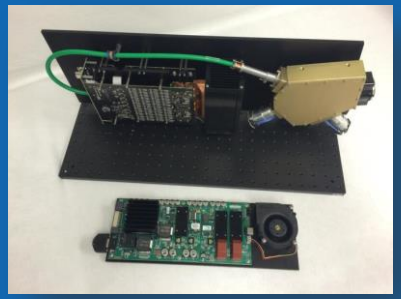
- Cooperative Agreement between Automotive Coalition for Traffic Safety (ACTS) and NHTSA

Public-Private Partnership

Where We Began & Where We Are Now

Breath-Based System:

85% decrease in size



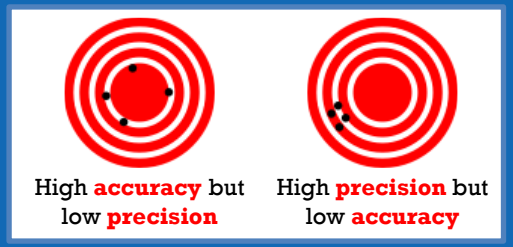
Touch-Based System:

93% decrease in size
Multiple laser sensors

DADSS Performance Specification

- Federal Register Vol. 58 No. 179
  - Uses a Breath Alcohol Sample Simulator (BASS)
  - Produces consistent vapor concentration
  - Alcohol reference solutions prepared gravimetrically (±3%)
  - Temperature regulated to ensure reproducible results of each "breath
- Prototypes evaluated against the following performance specifications:
  - Measure from 0.01% to 0.12% BAC
  - Measurement time = 325 milliseconds
  - Accuracy and Precision
  - 0.07%-0.09% BAC → ±0.0003% BAC

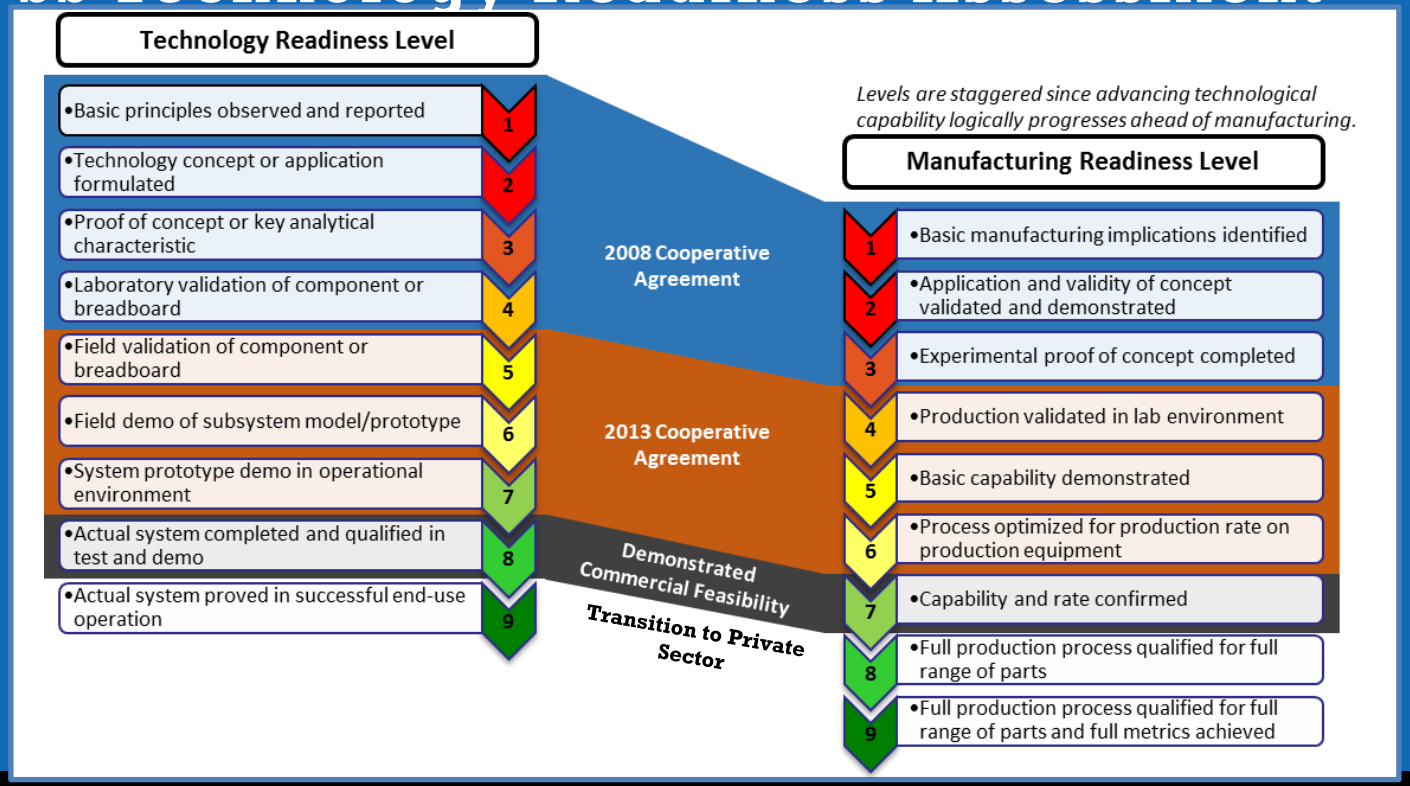
% BAC	DADSS Accuracy	58 FR 48705 §4.1	DADSS Precision	58 FR 48705 §4.1
0.010 - 0.050	0.0010	0.0050	0.0010	0.0042
0.050 - 0.070	0.0007	0.0050	0.0007	0.0042
0.070 - 0.090	0.0003	0.0050	0.0003	0.0042
>0.090	0.0010	0.0050	0.0010	0.0042



More accurate calibration source required for DADSS program

NHTSA

DADSS Technology Readiness Assessment

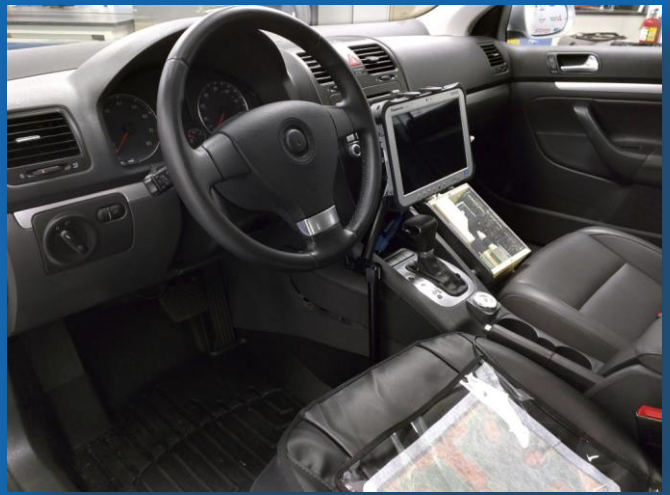


NHTSA

DADSS Overview Video (www.dadss.org)

What DADSS Has Accomplished

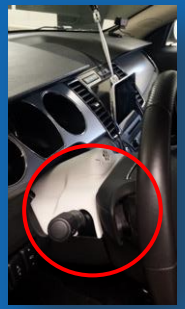
- 11 patent applications worldwide



Breath-Based System

Initial Concept

2nd Generation

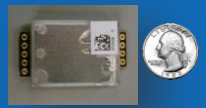


Research Vehicle Integration

1st Generation

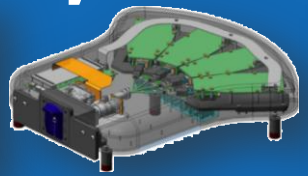
3rd Generation

Future

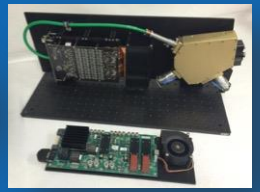


Touch-Based System

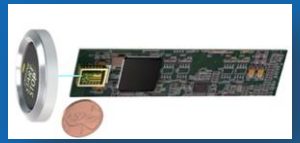
Initial Concept



2nd Generation

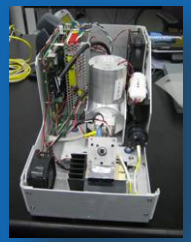


4th Generation

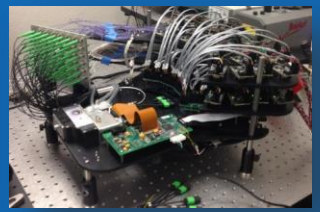


Future

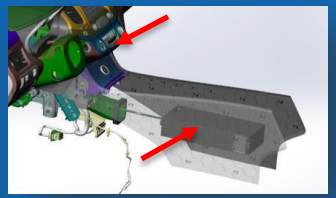
1st Generation



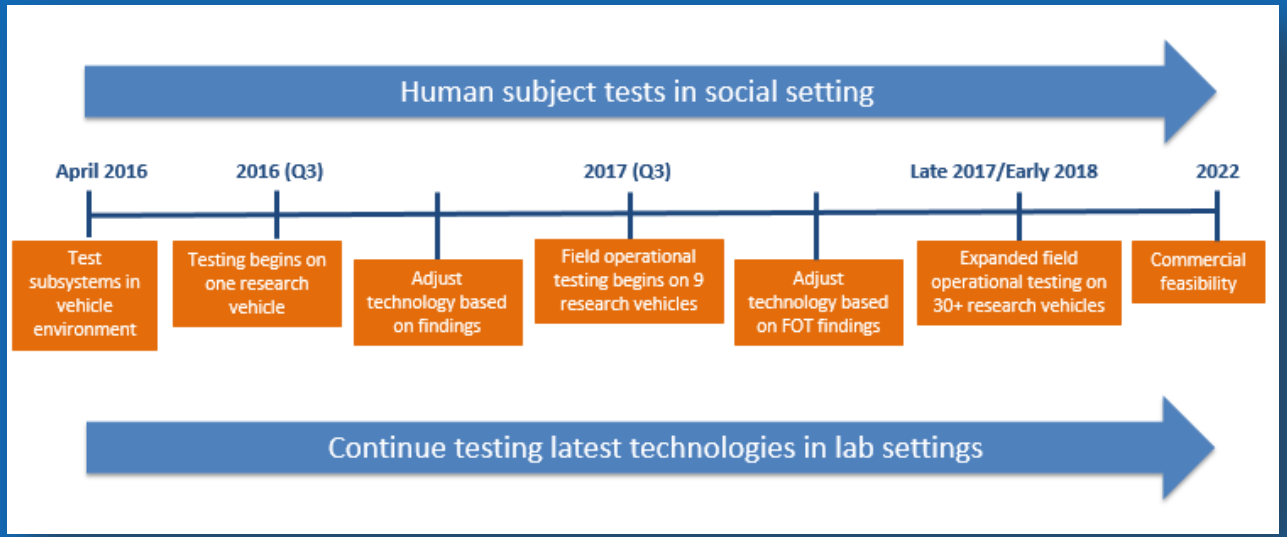
3rd Generation



Research Vehicle Integration



Timeline



NHTSA

Engaging the Public

- As the research progresses we will deploy a phased approach to increase
- **Awareness** of the technology and how it works
- **Acceptance** of the technology as a good auto safety system worth buying
- **Demand** for the technology in their own car or their children's cars

DADSS Focus Groups and Survey

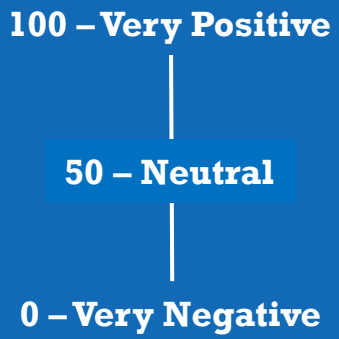
- Objectives
- Help inform in the development of strategic communications and consumer acceptance efforts

- Methodology
- Conducted eight (8) focus groups among 72 respondents in October 2014
- Conducted a national online survey among N=1,006 adults age 21 or older.
  - N=506 parents/guardians of children ages 14-20.
  - N=500 social to heavy drinkers
  - N=500 new motor vehicle buyers

Respondents have a very positive reaction to the technology

Reaction to Description of the New Technology (0–100 scale) – National Survey

	Mean Rating	% Rating 80 to 100
Adults Age 21 or Older	75	58%
Parents of Kids 14-20	77	62%
Social/Heavy Drinkers	73	55%
New Buyers	78	63%



gmmb cause the effect | GCO PUBLIC OPINION STRATEGIES

NHTSA

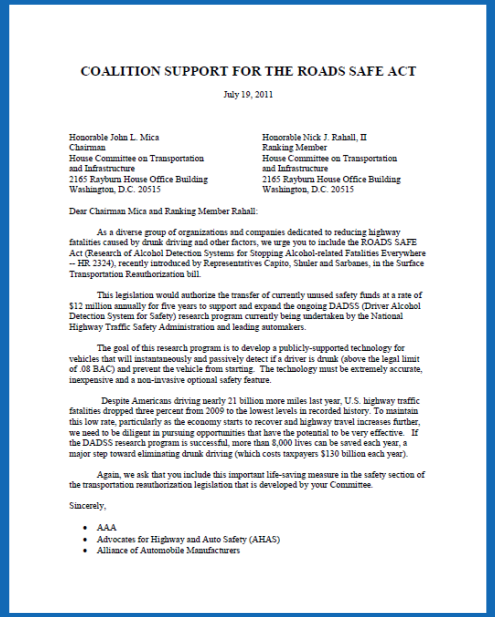
What was the most powerful?

- The technology takes the guesswork out of BAC measurements – letting the driver know if he/she is at or above the legal limit.

- Parents will be able to protect their children by programming the system to zero—the legal limit for drivers under 21.

- It will be an optional feature.

Broad Coalition



COALITION SUPPORT FOR THE ROADS SAFE ACT

July 19, 2011

Honorable John L. Mica
Chairman
House Committee on Transportation and Infrastructure
2165 Rayburn House Office Building
Washington, D.C. 20515

Honorable Nick J. Rahall, II
Ranking Member
House Committee on Transportation and Infrastructure
2165 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairman Mica and Ranking Member Rahall:

As a diverse group of organizations and companies dedicated to reducing highway fatalities caused by drunk driving and other factors, we urge you to include the ROADS SAFE Act (Research of Alcohol Detection Systems for Stopping Alcohol-related Fatalities Everywhere -- HR 2324), recently introduced by Representatives Capito, Shuler and Sarbanes, in the Surface Transportation Reauthorization bill.

This legislation would authorize the transfer of currently unused safety funds at a rate of $12 million annually for five years to support and expand the ongoing DADSS (Driver Alcohol Detection System for Safety) research program currently being undertaken by the National Highway Traffic Safety Administration and leading automakers.

The goal of this research program is to develop a publicly-supported technology for vehicles that will instantaneously and passively detect if a driver is drunk (above the legal limit of .08 BAC) and prevent the vehicle from starting. The technology must be extremely accurate, inexpensive and a non-invasive optional safety feature.

Despite Americans driving nearly 21 billion more miles last year, U.S. highway traffic fatalities dropped three percent from 2009 to the lowest levels in recorded history. To maintain this low rate, particularly as the economy starts to recover and highway travel increases further, we need to be diligent in pursuing opportunities that have the potential to be very effective. If the DADSS research program is successful, more than 8,000 lives can be saved each year, a major step toward eliminating drunk driving (which costs taxpayers $130 billion each year).

Again, we ask that you include this important life-saving measure in the safety section of the transportation reauthorization legislation that is developed by your Committee.

Sincerely,

- AAA
- Advocates for Highway and Auto Safety (AHAS)
- Alliance of Automobile Manufacturers

AAA
Advocates for Highway and Auto Safety
Alliance of Automobile Manufacturers
Allstate Insurance
American Academy of Pediatrics
American Association of State Highway and Transportation Officials
American Automotive Policy Council
American Highway Users Alliance
American International Automobile Dealers Association
American Trucking Associations
Association of Global Automakers
Distilled Spirits Council of the United States
Governors Highway Safety Association
MADD
National Association of Minority Automobile Dealers
National Beer Wholesalers Association
National Organizations for Youth Safety
National Safety Council
Nationwide Insurance
Safe Kids USA
State Farm Mutual Insurance Company
The Century Council
Wine and Spirits Wholesalers of America

New Partners

- In December 2016, Virginia became the first state to enter into a voluntary partnership with the DADSS program as federal and Virginia state officials announced $5.1 million in funding to help further develop and deploy DADSS.
- The state will be involved at various levels, from manufacturing and vehicle integration, to field operational tests, as well as public awareness and acceptance.
- States are a natural partner for the deployment of the technology across the country, and we look forward to working with Virginia officials in 2017.

What Comes Next

- Improve speed, accuracy and precision
- Reduce size and cost
- Conduct real world tests for reliability and durability
- Anticipate and prevent circumvention

NHTSA

THANK YOU

chris.monk@dot.gov